STATUS OF APEC COAL MINE GAS PROJECT IN CHINA

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ABSTRACT

Methane gas (coal mine gas) emitted into the atmosphere due to coal mining is not only a problem for mine safety but also an undesirable influence on global warming. Therefore, we will accelerate the diffusion of technologies for coal mine gas recovery through demonstration projects such as the APEC Coal Mine Gas (CMG) Project. This Project will contribute much to the prevention of global warming, coal mine safety and effective use of energy resources. The status of the Project is introduced below, focusing on Phase 3, which was completed in 1999.

This is the third presentation of the Project, following presentations at the APEC Fifth Technical Seminar in the U.S. in 1997, and at the Sixth Technical Seminar in Japan in 1998.

1) INTRODUCTION

At the APEC Osaka summit meeting in November 1995, an "ACTION PROGRAM FOR ENERGY" was adopted. In this program, it was agreed to explore cooperative multilateral projects to reduce climate change as an activity for "Reducing Environmental Impacts in the Energy Sector." This effort may involve demonstration projects leading to joint implementation. One objective is to investigate the recovery and utilization of CMG in order to reduce the release of coal mine gas into the atmosphere in APEC economies. Based on the results, a joint multilateral demonstration project for recovery and utilization of CMG is being examined and implemented.

The main target group is China, and the benefits of the study are most clearly recognized by people within the project area. It is hoped that through dissemination of project results, the private sector will take an interest in developing commercial CMG projects in member economies, thus broadening the base of potential users of the project technologies.

2) PLANNED PROJECT OUTPUTS

It is proposed that a joint multilateral demonstration for CMG recovery and utilization be implemented in coal producing economies with the cooperation of APEC member economies. Technical training and dissemination of this technology should be conducted for the benefit of the developing economies. Based on operational results achieved at the demonstration model plant, quantitative evaluation should be used to assess the effectiveness of the CMG project in reducing global warming.

Specifically, Phase III of the project involves installation of a demonstration system for the recovery and utilization of CMG. It includes improvement of the CMG recovery system in seven mines of the Tiefa Coal Industry (Group) Limited Liability Company (former Tiefa Coal Mining Administration), at Tiefa city, Liaoning Province, PRC. It also

includes improvement of a gas storage facility and pipeline network to allow CMG use in Tiefa city and Tieling city; the project will be completed in 2002.
Participating APEC economies decide at the Sub-group Meeting how to share tasks and coordinate implementation of this project.

3) PROJECT SCHEDULE

The project has been divided into three phases, including publication and dissemination; the periods and objectives for each phase are as follows:
Phase I – (Basic Study in 1996) Experts from Japan, China, Australia and the United States conducted field surveys and site selection; and . the site chosen is the Tiefa Coal Mining Administration (CMA) and Tieling City of Liaoning Province, China.
Phase II – (Feasibility Study in 1997) The feasibility study and conceptual design was continued into 1998; experts from Japan, China and the U.S. conducted a site survey of Tiefa CMA and Tieling City. Their objective was to get data and information for a preliminary study and the basic design of a demonstration project of CMG drainage and utilization..
Phase III – (Demonstration from 1998 to 2002) Detailed design, construction and operation work began in 1998. Current plans include the capture of methane from the seven operating coal mines at Tiefa, and transportation of the gas to nearby Tieling City for use in households. Project leaders also considered using the gas for power generation, but unless additional resources are found, this option will not be pursued.

4) RESULTS OF PHASE III ACTIVITIES

Project Target

The goal of the project is to raise the Tiefa coal mines' CMG utilization factor from the current rate of approximately 5.5% to approximately 32%. Related objectives are to cut down on greenhouse gas emissions, enhance coal mine safety, and make effective use of the yet-to-be-used energy.
In conjunction with the conceptual design formulated in FY1998, the Japan Coal Energy Center (JCOAL) and Tiefa CMA have investigated a range of data shown in the table below.

- Gas emission into the atmosphere is to be reduced and the amount used for town gas to be increased to approximately 39.8 million Nm^3/year (utilization factor: 32%); this is equivalent to the demand of 165,000 households.
- The Daxing Mine, which has the highest coal output and the largest gas emission volume, has been selected as the model mine, and the Japanese partners will install gas drainage equipment in it.
- The Japanese partners will install gas utilization equipment for compression, heating value adjustment, and storage of the CMG recovered from the seven mines.
- The methane concentration of the gas supplied to town is maintained at 41 vol.% (low calorific value, 3,500 kcal/Nm^3); this value has been set because of the gas tariff, and to suit the gas appliances used in Teiling City.

Outline of the Gas Recovery Systems

At the project's subject coal mines, efforts shall be made to increase the amount of gas recovered and increase/stabilize the concentration of gas by introducing new gas drainage, gas induction, sealing and monitoring/control systems. JCOAL will take charge of the Daxing mine, while Tiefa Company will take charge of the remaining mines.

Newly installed facilities are as follows.

- An efficient gas drainage drilling system consisting of pumps, bits, stabilizers and other equipment for drilling medium holes (about 300 m in depth) to drain disturbance gas;
- A gas induction system consisting of drip traps, valves, etc. for use around gas drainage holes.
- A wet-sealing system consisting of mixers, back-filling pumps, etc. that can supplant the currently used dry-type sealing facilities.
- A CMG monitoring and control system with sensors, transmitting and receiving equipment, display and recording equipment etc., for remote continuous observation of facilities, and a control system for gas drainage of sealing.

Newly introduced technologies are as follows.

1) Gas drainage technology:

- Drilling technology to draw up the best possible boring plans (in terms of boring position, direction, inclination, length and drill hole-mouth caulking methods, etc.) in conjunction with the introduction of new boring machines;
- Medium length horizontal drilling technology;
- Mine gas observation technology (observation techniques, system, data recording, etc.), and,
- Sealing material filling technology (sealing techniques, and methods for observing gas inside sealed-off areas, etc.) in conjunction with the introduction of wet-sealing facilities.

2) Monitoring and control technology:

- Remote inspection technology to observe facilities continuously, and contingency response technology to cope with emergency situations such as power failures, and
- Technology to control gas drainage of sealing.

Outline of the Gas Utilization Systems

CMG recovered from the seven Tiefa coal mines will be connected to pipelines on the surface to increase the amount of gas that can be used, and stabilize its concentration. The recovered gas will be supplied to Tiefa Company residences and the cities of Tiefa and Tieling for use as town gas.

JCOAL will take charge of some portions of the storage and pressurizing facilities and monitoring/control systems, while Tiefa Company will be responsible for other portions, and for the remaining facilities, buildings, pipelines and the like.

The CMG recovered from the Tiefa mines is stored in a 50,000 Nm^3 dry-type gas holder. The low-pressure part, at 500 mmH_2O, extends up to this part, and from the next step onward the high-pressure zone begins for pressurizing gas. The CMG is pressurized to 7

kg/cm^{2}G by a compressor. For continuous operation, two compressors should be available (one with a capacity of 4,500 Nm^3/hr) and one should be on standby.
The methane concentration at the compressor outlet is expected to be 45–50 vol.%. To reduce this to the consumer value of 41 vol.%, it is diluted with compressed air; this calorific adjustment unit has a capacity of 9,000 Nm^3/hr. Before the commercial gas is pressurized and fed to consumers in Tieling City, it is stored in a spherical gas holder. This holder has a geometric capacity of 2,500 m^3 (equivalent to 17,500 Nm^3). This provides sufficient stock for two hours supply even when the first-stage compressor has broken down. As a safety control measure in the first compressor stage, tetrahydrothiofen is added as an odorant.
Newly introduced facilities are as follows.

- A network pipeline to connect the seven mines and pipeline to Tieling city;
- Gas storage facilities: Dry type gas holder and spherical gas holder;
- Pressure feeding facilities: Compressor, calorific value adjustment unit and dehydrating facilities (drain tank for spherical gas holder); and,
- Monitoring and control systems: Sensors, transmitting and receiving equipment, display and recording equipment, etc.

Newly introduced technologies are as follows.

- Gas-balance management technology to control flow rates, pressures, inventory levels and the like with the help of monitoring/control systems, as well as leakage-check technology with gas detectors, and
- Quality-control technology to monitor heating value management by means of heat regulating facilities, gas chromatography and QC technology employing dehydrating facilities.

Environmental Impact Assessments

Trial calculations of quantitative reductions in greenhouse gas emissions will be made in terms of the amount of carbon dioxide. Where environmental impact assessments are concerned, research and studies must be conducted to come up with applicable techniques.

Project Organization

<table>
<tr><td colspan="2">APEC Energy Working Group</td></tr>
<tr><td colspan="2">Experts' Group on Clean Fossil Energy</td></tr>
<tr><td colspan="2">Coal Technology Program</td></tr>
<tr><td colspan="2">Coal Mine Gas Project</td></tr>
<tr><td>Japan</td><td>P.R.C.</td></tr>
<tr><td>Ministry of International Trade and Industry</td><td rowspan="2">State Development Planning Commission

State Administration of Coal Industry</td></tr>
<tr><td>New Energy and Industrial Technology Development Organization (NEDO)</td></tr>
<tr><td>Japan Coal Energy Center (JCOAL)</td><td>Tiefa Coal Industry (Group) LLC</td></tr>
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Outlook for amount of gas recovery and utilization (in terms of pure methane)

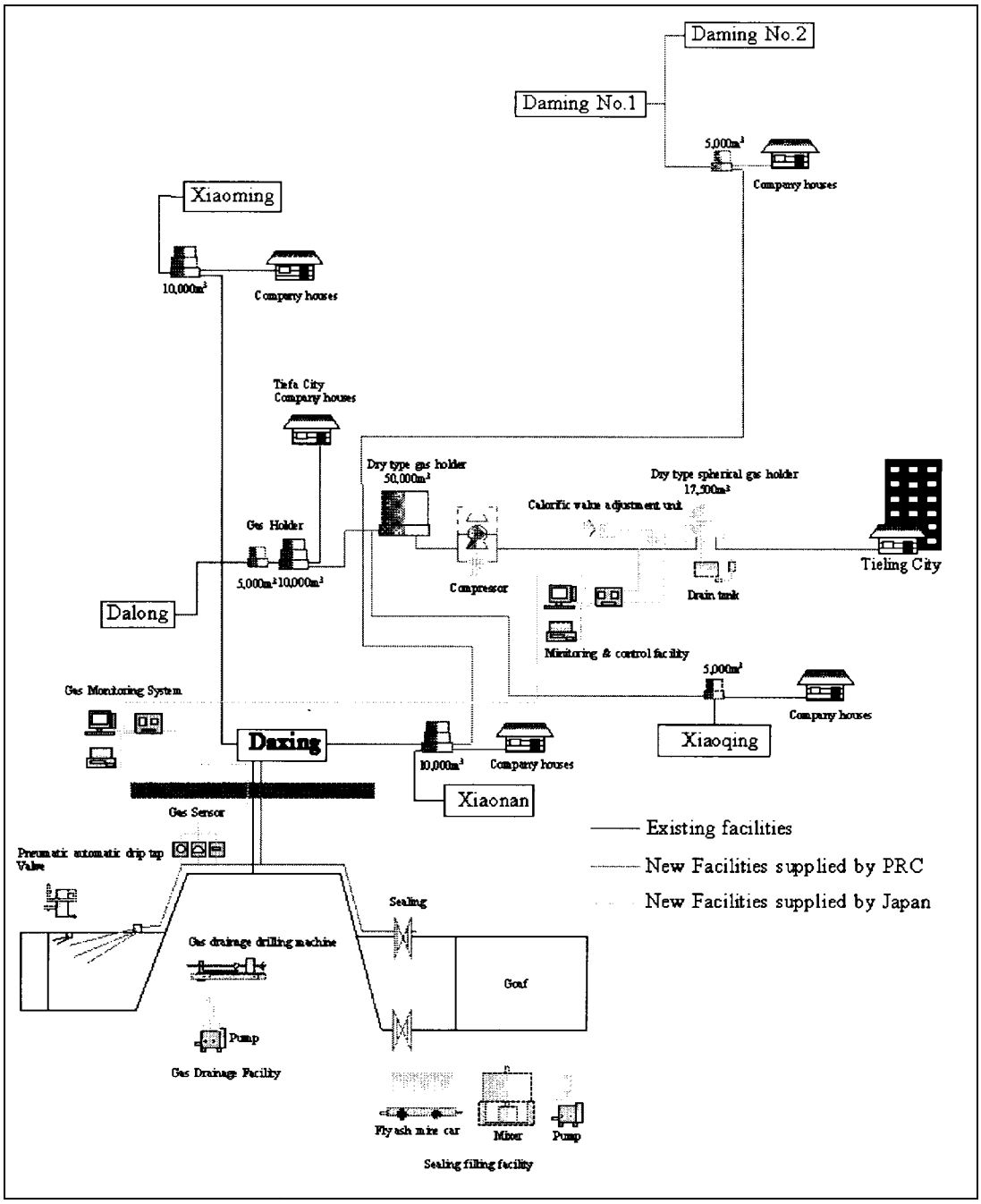
	1997	2003 (at conclusion of the project)
Amount of gas emitted (1,000 m^3)	128,370	123,500
Amount of gas recovered (1,000 m^3)	32,950	43,890
Amount of gas used (1,000 m^3)	7,000	39,800
Gas utilization factor (%)	5.5	32

Amount of Gas Emission, Drainage and Utilization at Tiefa CMA
(Actual data for 1997, Gas Volume converted to Methane)

Mine Name	Coal Production (10^3t)	Gas Resources (10^6Nm3)	Gas Drainage (10^6Nm3)	Gas Utilization (10^6Nm3)
Daming No1	1, 365	19. 2	2. 0	Released
Daming No2	687	10. 7	1. 4	Released
Xiaoming	1, 720	13. 6	3. 2	Partially used
Dalong	2, 400	18. 5	5. 5	Partially used
Xiaonan	2, 415	19. 5	4. 9	Partially used
Xiaoqing	2, 130	12. 6	4. 1	Partially used
Daxing	2, 750	34. 2	11. 8	Partially used
Total	13, 467	128. 3	32. 9	7. 0

Amount of Gas Emission, Drainage and Utilization at Tiefa CMA
(After Project in 2003, Gas Volume converted to Pure Methane)

Mine Name	Coal Production (10^3t)	Gas Resources (10^6Nm3)	Gas Drainage (10^6Nm3)	Gas Utilization (10^6Nm3)
Daming No1	1, 200	19. 2	2. 4	
Daming No2	600	10. 7	1. 6	
Xiaoming	1, 600	13. 6	3. 8	
Dalong	2, 300	18. 5	7. 1	
Xiaonan	2, 300	19. 5	6. 6	
Xiaoqing	2, 000	12. 6	4. 6	
Daxing	3, 000	34. 2	17. 8	
Total	13, 000	128. 3	43. 9	39. 8



Layout Plan of Facilities (after the project)

Task Sharing for Both Countries

	Japanese Side	Chinese Side
Plant Design	O	
Planning for Overall Operation		O
Gas Recovery Equipment for Daxing Mine	O	
Gas Recovery Equipment for Other Mine		O
Civil Work for Gas Utilization Section		O
Compressor, Caloric Value Adjustment & Gas Holder	O	
Central Monitoring & Control System	O	
Gas Pipe Line		O
Technology Transfer	O	
Demonstration Operation	O	O

Reduction of GHG emission during the Project

(Preliminary calculation)

('000 CO_2 tons/year)

Year	GHG Reduction
2000	360
2005	440
2010	450

Simple Economic Feasibility Calculation

Assumed Preconditions

Total investment	33 million US$
Annual gas sales volume	40 million Nm3
Unit price of gas	0.22 US$/Nm3

Income	8.8 million US$
Outgo	million US$
Depreciation & maintenance	3.8
Operating cost	0.8
Overhead	0.9
Total	5.5
Profit	3.3 million US$/year

List of equipment supplied by Japan

Equipment	Specification	Number
<Daxing Mine>		
1. Gas Drainage Facility		
Drilling machine	Capacity 300 m	2 sets
Pump		2 sets
Rod		750 m
Casing		2 sets
Bit	Diamond bit and reaming bit	2 sets
Stabilizer		2 sets
Cutting tool (including tap)		2 sets
Switch box		2 sets
2. Gas Induction Facility		
Pneumatic Automatic drip tap		2 units
Valve		10 units
3. Sealing filling facility		
Mixer	For fly ash mixing	1 set
Pump	For fly ash slurry	1 set
Fly ash mine cars		20 cars
Piping	For sealing	1 set
Valve	For sealing	1 set
4. Monitoring facility		
Sensors in gas pipeline	To monitor concentration of CH4 and CO, gas flow rate, pressure and temperature	3 sets
Sensors in roadway	To monitor concentration of CH4 and gas flow rate	1 set
Transmission cable		1 set
Transmitting facility		2 sets
Receiving facility		1 set
Display facility		1 set
Recording facility		1 set
5. Control facility		
Solenoid valve and differential manometer	For sealing	1 set

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Equipment	Specification	Number
<Gas Supply Center>		
1. Pressure feeding facility		
Compressor	Capacity 4,500 $\underline{N}m^3$/hour	1 set
2. Gas content control facility		
Calorific value adjustment unit with dilution air compressor	Capacity 9,000 $\underline{N}m^3$/hour	1 set
3. Gas storage facility		
Dry type spherical gas holder	Geometric volume2,500 m^3	1 set
4. Dehydration facility		
Drain tank for spherical gas holder	Capacity 5 m^3	1set
5. Monitoring and control facility		
Sensor	Gas flow rate, heating value, pressure, temperature	1 set
Local measuring control panel	For daily reporting	1 set
Monitoring equipment	Personal computer	1 set

Overall Schedule